

REMARKS/ARGUMENTS

Claims 1, 9, 17-19 and 25 remain pending herein.

In a telephone conference on July 19, 2004, SPRE Tierney stated that the U.S. PTO has received certified copies of the five priority documents for the Japanese applications from which the present application claims priority. It is respectfully requested that the next Office Action contain an acknowledgment that the certified copies have been received.

In response to the objection to the Amendment filed March 4, 2004, the sentence in the specification, page 38, lines 18-20 has been amended to read "[I]n the case that an organic phosphorus compound is used, the compound may have a P=O linkage" (the original specification included the statement "[i]n the case that an organic phosphorus compound is used, the one having a P=O linkage." It is respectfully requested that the U.S. PTO reconsider and withdraw this objection.

In response to an objection to claim 1, claim 1 has been amended as requested in the Office Action, page 3, lines 5-6, namely, by changing "as a electrolyte" to --as an electrolyte--. It is respectfully requested that the U.S. PTO reconsider and withdraw this objection.

Claims 6-9 and 26-28 were objected to under 37 C.F.R. 1.75(c). As noted above, claims 6-8 and 26-28 have been canceled, rendering this rejection moot as to those claims. Regarding claim 9, the Office Action contains a statement that the recitation in claim 9 does not further limit claim 1 because claim 9 does not require that compound (b) be selected to be in the positive electrode, negative electrode, the separator and/or the electrolyte solution. Claim 1, amended as set forth above, now requires that a ring compound unitarily contained in a molecule with a strong acid be in the positive electrode, the negative electrode, the separator and/or the electrolyte solution, and claim 9 recites that the strong acid is hydrogen

chloride or sulfuric acid. It is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

Claims 1, 6-9, 17-19 and 25-28 were rejected under 35 U.S.C. §112, first paragraph. The Office Action contains statements that the specification “does not reasonably provide enablement for all compounds having an organic base and an inorganic acid which are unitarily combined in a molecule.”

Claim 1, amended as set forth above, recites that at least one of the positive electrode, the negative electrode, the separator and the non-aqueous electrolyte solution contains a ring compound containing at least one nitride in a ring and a strong acid which are unitarily combined in a molecule. It is respectfully noted that the specification contains disclosure which would enable persons of skill in the art to carry out the invention as recited in claim 1 without having to engage in any undue experimentation. It is further noted that the specification specifically describes six ring compounds which contain at least one nitride in a ring (specification, pages 17-19).

In addition, the six compounds exemplified in Table 6 on page 55 and Table 7 of page 57 of the original specification are compounds in which an organic base contains a ring compound containing at least one nitride in a ring and an inorganic acid is made of a strong acid. Further, as described in the original specification, page 19, line 23 to page 20, line 9, the organic base traps HF and the inorganic acid combines with Li (e.g., LiCl).

It is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

Claims 6-8 were rejected under 35 U.S.C. §112, second paragraph. As noted above, claims 6-8 have been canceled. The expression “strong acid” now appears in claim 1. The expression “strong acid” is well known to encompass the group of acids consisting of HCl, HCr, HI, HNO₃, HClO₄, and H₂SO₄. Attached is an excerpt from Masterton, Slowinski and

Walford, Chemistry (1980), and an excerpt from Masterton and Slowinski, Chemical Principles (1977).

It is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

Claims 1, 6-9, 17-19 and 25-28 were rejected under 35 U.S.C. §102(e) over Japanese 2000-077103. JP '103 discloses 2,2'-bipyridine. 2,2'-bipyridine combined with HF does not fall within the scope of claim 1, amended as set forth above, because, as is well known in the art, HF is not a strong acid (see the excerpt from Masterton and Slowinski, Chemical Principles, page 482, last four lines).

It is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

Claims 1, 6-9, 17, 19 and 26-28 were rejected under 35 U.S.C. §102(b) over Japanese 06-060877 (JP '877).

A higher amine halogen acid salt as disclosed in JP '877 does not include a ring compound containing at least one nitride in a ring (unitarily combined with a strong acid in a molecule). Accordingly, it is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

Claim 25 was rejected under 35 U.S.C. §103(a) over JP '877 in view of U.S. Patent No. 5,700,597 (Zhong '597).

Zhong '597 is applied for alleged disclosure of a lithium battery as a high density source for an electric vehicle. Neither JP '877 or Zhong '597 contain any disclosure which would motivate one of skill in the art to attempt to modify the higher amine halogen acid salt disclosed in JP '877 so as to include a ring compound containing at least one nitride in a ring (unitarily combined in a molecule with a strong acid).

Accordingly, it is respectfully requested that the U.S. PTO reconsider and withdraw this rejection.

In view of the above, claims 1, 9, 17-19 and 25 are in condition for allowance.

If the Examiner believes that contact with Applicants' attorney would be advantageous toward the disposition of this case, the Examiner is herein requested to call Applicants' attorney at the phone number noted below.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1446.

Respectfully submitted,

September 14, 2004

Date



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Enclosures:

Excerpt from Masterton, Slowinski and Walford, Chemistry, 1980

Excerpt from Masterton and Slowinski, Chemical Principles (1977).

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Front cover photograph is a photomicrograph of a crystal of a cyclic monomer grown in a gaseous environment. This monomer is a building block for the production of a solid-state polymer. (Photo courtesy of National Bureau of Standards, and originally published in *Chemistry* magazine.)

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TABLE 19.3 TYPICAL ACID-BASE INDICATORS

NAME	pH INTERVAL	ACID COLOR (Low pH)	BASE COLOR (High pH)
Methyl violet	0.0–1.6	yellow	violet
Methyl yellow	2.9–4.0	red	yellow
Methyl orange	3.1–4.4	red	yellow
Methyl red	4.8–6.2	red	yellow
Bromthymol blue	6.0–8.0	yellow	blue
Thymol blue	8.0–9.6	yellow	blue
Phenolphthalein	8.2–10.0	colorless	pink
Alizarine yellow	10.1–12.0	yellow	red

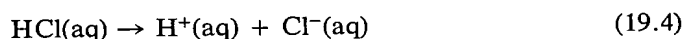
principle is used to prepare pH paper, widely used to test the acidity of biological fluids and for soil testing. Strips of paper impregnated with a mixture of indicators can be designed to give gradations of color over a wide or narrow pH range.

In a more qualitative way, the acidity or basicity of a solution can be established by some very simple tests. Dilute acidic solutions are characteristically sour; lemon juice, vinegar, and rhubarb get at least part of their taste from the acids they contain. It wouldn't be advisable to test-taste solutions which are highly acidic, since there are various undesirable side effects, to say the least. Such solutions, however, will react with zinc or magnesium metal, evolving hydrogen gas. They will also react readily with carbonates, in which case bubbles of carbon dioxide are given off.

Basic solutions typically have a bitter taste and feel slippery. A solution of lye, sodium hydroxide, feels very slippery, but this is because it is dissolving a surface layer of skin. Probably a safer test for bases is to add a small amount of a solution of a magnesium salt such as $MgCl_2$. The formation of a white precipitate of magnesium hydroxide indicates the solution is basic.

19.3 STRONG ACIDS AND BASES

In order for a solute to make a solution acidic it must somehow release H^+ ion to the solution. The simplest kind of substance which can do this is one like HCl , which on being dissolved in water undergoes the following reaction:



For this reaction, we can assume K_c is infinite

Strong acids, of which HCl is a classic example, ionize essentially completely in water in a reaction like 19.4, producing hydrogen ion and an anion. In a solution of a strong acid there are assumed to be no acid molecules, but only hydrogen ions and the anions resulting from the dissociation. In a 0.5 M HCl solution, made by dissolving a half mole of $HCl(g)$ per liter of solution, $[H^+]$ is 0.5 M, $[Cl^-]$ is 0.5 M, and $[HCl]$ is virtually *zero*. In solution, then, HCl behaves as a strong electrolyte. It conducts the electric current very well and has the colligative properties of an ionized substance.

There are only a few strong acids; the six most important ones are listed in Table 19.4. Since all these acids are very soluble in water, it is possible to use them to prepare solutions in which $[H^+]$ is very high. Concentrated HCl is about 12 M and concentrated HNO_3 is about 16 M. Sulfuric acid is furnished commercially as essentially pure H_2SO_4 ; that liquid contains almost no free water, is a very strong dehydrating agent and a good oxidizing agent, as well as having acid

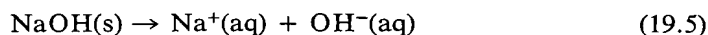
TABLE 19.4 THE STRONG ACIDS AND BASES

ACIDS		BASES
Hydrochloric acid	HCl	Hydroxides of the 1A metals: LiOH, NaOH, KOH, RbOH, CsOH
Hydrobromic acid	HBr	
Hydriodic acid	HI	Hydroxides of the 2A metals: Mg(OH) ₂ , Ca(OH) ₂ , Sr(OH) ₂ , Ba(OH) ₂
Nitric acid	HNO ₃	
Perchloric acid	HClO ₄	
Sulfuric acid	H ₂ SO ₄	

properties. HCl, HNO₃, and H₂SO₄ are all very important industrial chemicals; each has its own characteristic properties, but they share in common the capacity to furnish high concentrations of hydrogen ion in water solutions. The "work-horse" acids of the chemistry laboratory are 6 M HCl, 6 M HNO₃, and 3 M H₂SO₄, sometimes referred to as "dilute" acids.

Analogous to the strong acids are the **strong bases**, of which NaOH is the most common example. Sodium hydroxide dissolves very readily in water to give a solution containing Na⁺ and OH⁻ ions.

"Strong" means that an acid or base is completely dissociated; nothing else is implied



In solution NaOH is effectively 100 per cent ionized, as are all the strong bases. In 0.8 M NaOH solution, made by dissolving 0.8 mole of NaOH per liter of solution, [Na⁺] is 0.8 M, [OH⁻] is 0.8 M, and [NaOH], the concentration of undissociated NaOH, is just about zero.

There are not many strong bases; most of them are listed in Table 19.4. They are essentially limited to the hydroxides of the 1A and 2A metals. Of these bases, only NaOH and KOH are commonly used in the chemistry laboratory. All compounds of lithium, rubidium, and cesium are expensive; the 2A hydroxides have limited solubilities. Calcium hydroxide is often used in industry when a strong base in needed and high solubility is not critical.

Using stock solutions of strong acids and bases it is possible to prepare, by dilution, acidic and basic solutions of nearly any concentration.

Example 19.2 How would you prepare, from 1 M HCl and 1 M NaOH stock solutions, one liter of a solution in which [H⁺] is

- 4×10^{-3} M?
- 5×10^{-13} M?

Solution

- Since HCl is completely ionized, the solution to be made will have to be 4×10^{-3} M HCl. One liter of such a solution will contain 4×10^{-3} moles HCl. We need to find the volume of 1 M HCl which will contain that number of moles; we use the relation:

$$\text{no. moles HCl} = M \times V; V = \frac{4 \times 10^{-3} \text{ moles}}{1 \text{ mole/liter}} = 4 \times 10^{-3} \text{ liter} = 4 \text{ ml}$$

We measure out 4 ml 1 M HCl and dilute to a volume of one liter, mixing the final solution well.

- We cannot prepare this solution by dilution of 1 M HCl with water, since the best we can do by that approach is to get essentially pure water, which has a [H⁺] of 10^{-7} M. Since the solution is basic, we make it from the stock 1 M NaOH.

FOURTH EDITION

CHEMICAL PRINCIPLES

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The cover photo shows an enormous storm on the surface of the sun, as observed from a satellite. The picture was taken at 304 Å in the light given off by He⁺ ions as they go from the $n = 2$ to the $n = 1$ state. We are grateful to NASA for the permission to use this photo.

Chemical Principles

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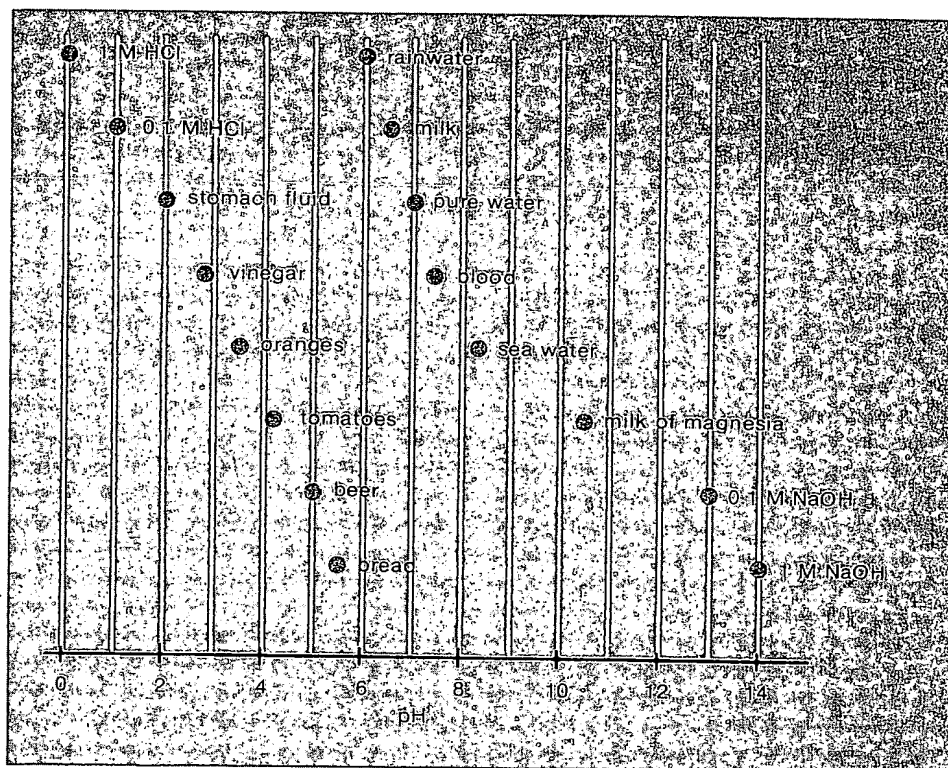


FIGURE 19.2

Most water solutions are not neutral since most solutes have acidic or basic properties.

Figure 19.2 shows the approximate pH of several common materials. Notice that most foods are at least slightly acidic. Many of these, especially fruits and certain vegetables, contain organic acids. Digestive fluids also tend to be acidic. The low pH of stomach fluids is due to the presence of HCl, about 0.01 M. Sometimes the pH in the digestive tract becomes too low, leading to an upset stomach. To relieve this condition, you take a product that is slightly basic. One possibility is sodium bicarbonate, NaHCO_3 (pH = 8.5). Another is milk of magnesia, $\text{Mg}(\text{OH})_2$ (pH = 10.5).

Too much pizza might cause this problem.

19.2 STRONG AND WEAK ACIDS

For our purposes, an acid can be defined as a species which, upon addition to water, increases the concentration of H^+ ions. Most commonly, an acid is a molecular substance which contains at least one hydrogen atom. We might represent its formula by HX. When added to water, it forms H^+ and X^- ions in solution. We distinguish between strong acids, which are completely ionized in dilute water solution:

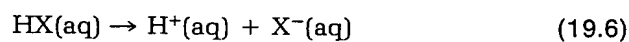
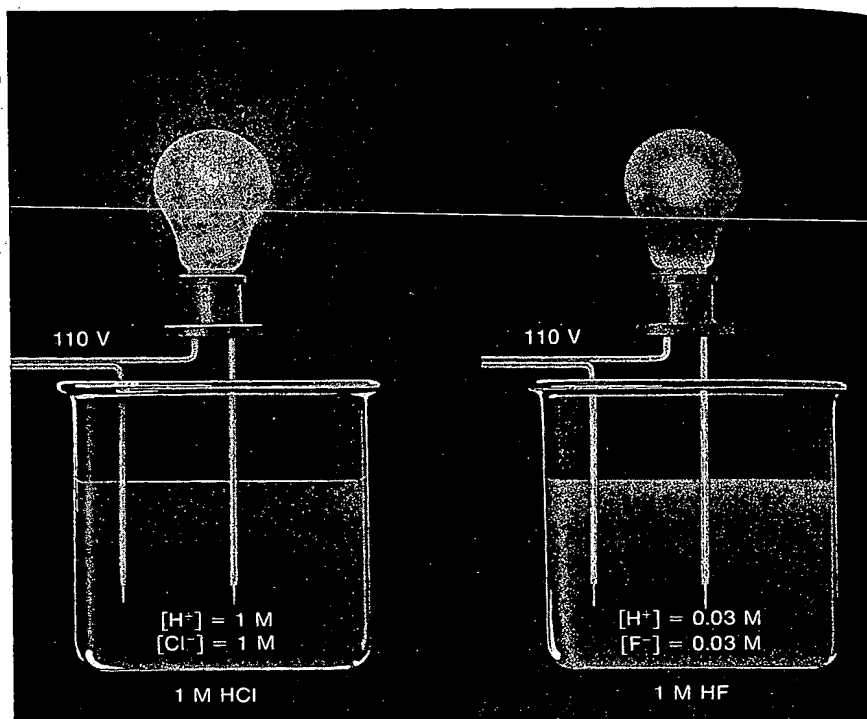
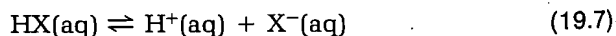


FIGURE 19.3

The conductance of a 1 M solution of a weak acid like HF is much less than that of a 1 M solution of a strong acid like HCl. The difference is due to the fact that HF is only slightly ionized, whereas HCl is completely ionized.



and weak acids, where ionization is incomplete:



In a solution of a strong acid, we expect to find no HX molecules. All of them have been converted to H^+ and X^- ions by Reaction 19.6. Putting it another way, the equilibrium constant for Reaction 19.6 is extremely large, approaching infinity. Hence the forward reaction, for all practical purposes, goes to completion.

The situation is quite different with a weak acid. Here, we expect to find an equilibrium mixture in water solution. This mixture contains measurable amounts of HX molecules, H^+ ions, and X^- ions. In one case, we might find that 10% of the weak acid was converted to ions. If this were so, we would say that the weak acid was 10% ionized.

One way to determine whether an acid is strong or weak is to measure the electrical conductivity of its water solution (Figure 19.3). Solutions of strong acids are good conductors because they contain high concentrations of ions. For example, 1 M HCl, which is completely ionized, contains 1 mol/l of H^+ and 1 mol/l of Cl^- . These ions carry the electrical current. The behavior of a weak acid such as HF is quite different. In 1 M HF, only about 3% of the HF molecules are converted to H^+ and F^- ions. Hence the concentrations of H^+ and F^- are only 0.03 M. This explains why 1 M HF is a poor conductor.

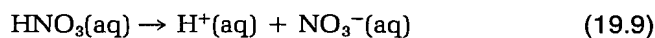
In 1 M HF, $[\text{HF}] = 0.97 \text{ M}$.

Common Strong Acids

There are only a few acids which are completely ionized in water. In fact, there are only six common strong acids. They are:

HCl	hydrochloric acid
HBr	hydrobromic acid
HI	hydroiodic acid
HNO ₃	nitric acid
HClO ₄	perchloric acid
H ₂ SO ₄	sulfuric acid

When these acids are added to water, the acid molecule dissociates completely. Two ions are formed. One is a positive ion, H⁺. The other is the negative ion derived from the strong acid. Thus we have:



EXAMPLE 19.4

Consider the strong acid HClO₄.

- Write a balanced equation for its ionization in water.
- If 0.1 mol HClO₄ is added to one liter of water, what is [H⁺] in this solution?

SOLUTION

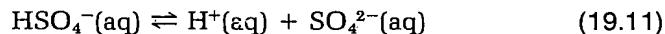
- $\text{HClO}_4(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{ClO}_4^-(\text{aq})$
- Since perchloric acid is a strong acid, it is completely ionized. 0.1 mol HClO₄ forms 0.1 mol H⁺. Hence:

$$[\text{H}^+] = \frac{0.1 \text{ mol}}{1 \ell} = 0.1 \text{ M} = 10^{-1} \text{ M}$$

In the sulfuric acid molecule, there are two hydrogen atoms. The first one ionizes completely.



For this reason, we call sulfuric acid a strong acid. The second ionization is incomplete:



Of the six strong acids, you are likely to find only three in the labora-

tory. These are HCl, HNO₃, and H₂SO₄. They are most often used as the dilute solutions:

dilute HCl	6 mol/ℓ
dilute HNO ₃	6 mol/ℓ
dilute H ₂ SO ₄	3 mol/ℓ

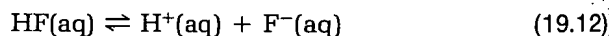
If you buy these acids from a supply house, you get the concentrated solutions.

Concentrated solutions of these acids are also available (12 M HCl, 16 M HNO₃, 18 M H₂SO₄). They are used for special purposes but are generally unpleasant to work with. Concentrated HCl has a pungent odor due to HCl gas over the solution. Concentrated HNO₃ is both colorless and odorless when pure. However, it often contains NO₂ gas, which has a brown color and a choking odor. The concentrated acid burns the skin and causes brown stains on clothing.

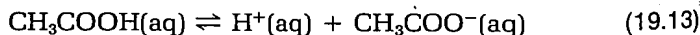
Concentrated sulfuric acid is particularly dangerous to work with. Its reaction with water (Equations 19.10 and 19.11) gives off a great deal of heat. Some water may actually be converted to steam by this reaction. If you ever have to mix concentrated sulfuric acid with water, always slowly add the acid to water, never the reverse.

Weak Acids

There are thousands of weak acids, far too many to list here. We will consider only a few of the more common weak acids. All of these are molecules which contain at least one ionizable hydrogen atom. In water solution, some of the acid molecules dissociate, forming an H⁺ ion and a negative ion. A simple example is hydrogen fluoride.



All of the common organic acids are weak. Perhaps the most familiar example is acetic acid, CH₃COOH, found in vinegar. In water, acetic acid undergoes the following reversible reaction:



The products are a proton, H⁺, and the acetate ion, CH₃COO⁻.

EXAMPLE 19.5

Nitrous acid, HNO₂, is a weak acid.

- Write a balanced equation for its (partial) ionization in water.
- When 0.1 mol of HNO₂ is added to one liter of water, 10% of it ionizes. Calculate [H⁺] in this solution.

SOLUTION

